

**REMARKS**

The Examiner's non-final Office Action dated July 28, 2003 has been received and its contents carefully noted. By the above amendments, claims 11 and 14 have been amended and claims 9 and 13 have been canceled; accordingly, claims 11, 12, 14 and 15 continue to be pending with claims 11 and 14 being independent. In light of the above amendments and the comments to follow, reconsideration of the instant application is respectfully requested.

With regard to the rejection of claims 11, 12, 14 and 15, under 35 U.S.C. § 102(b), as being anticipated by the teachings of Mikio et al. (JP '406), and claim 13, under 35 U.S.C. § 103(a), as being obvious in view of the teachings of Mikio et al. (JP '406), the Applicants assert that each of these rejections is improper in light of the amendments above and should be withdrawn. Initially, it is noted that the Examiner states that one of ordinary skill in the art at the time the invention was made would have considered the invention to have been obvious because the process step recited in instant product by process claim 13 does not necessarily lend patentability to the claimed product in light of the closeness of the hydrogen content of Mikio et al and that claimed, citing *Titanium Metals of America v. Banner*, 778 F.2d 775; 227 USPQ 773 (Fed. Cir. 1985). However, the structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art. See *In re Garnero*, 412 F.2d 276; 162 USPQ 221 (CCPA 1979) and MPEP Chapter 2113). The Applicants are of the opinion that the manufacturing process steps for the rare earth magnets presently claimed would impart distinctive structural characteristics to the final product which would not have been obvious to one of ordinary skill in the prior art and further provide unexpected improvement in the magnet properties.

As discussed in the specification, see paragraphs [0038]-[0039], [0051] and [0070]-[0083], a process step of embrittling an R-Fe-B rare earth alloy by hydrogen occlusion will increase the hydrogen content in the magnet alloy powder. Therefore, the hydrogen content would easily exceed the claimed range of 10 wt. ppm to 100 wt. ppm when using the material that was obtained by embrittling an R-Fe-B rare earth

alloy by hydrogen occlusion, and both the density and the coercivity of the final product are unsatisfactorily impacted. That is, as the inventors have discovered there is a relationship between the hydrogen content of the embrittled and sintered rare earth magnet and the ability to form sintered rare earth magnets having the desired density and coercivity (which do not deteriorate). Further, the Applicants have discovered (see Tables 3 and 4) each of these problems can be corrected by performing a sintering sequence which reduces the content of hydrogen in the sintered rare earth magnet to the levels presently claimed. Such magnets have improved density and higher coercivity than those magnets which do not undergo a dehydrogenation by the sintering sequence disclosed.

Specifically, the claims of the present application recite a hydrogen content in a range of 10 wt. ppm to 100 wt. ppm, even though the R-Fe-B rare earth magnet is manufactured of a material obtained by embrittling an R-Fe-B rare earth alloy by hydrogen occlusion. The magnet defined by the claims is produced by a novel production method disclosed in the present application. The method comprises a step of embrittling an R-Fe-B rare earth alloy by hydrogen occlusion, and a step of sintering a powder compact of the R-Fe-B rare earth alloy at two different temperatures.

According to the two-step sintering process disclosed in the present application, a rare earth hydrogen compound ( $RH_x$ ) releases hydrogen to form rare earth metal at the first stage. More specifically, during the first-stage heat treatment at a temperature of 700 °C or more, there occurs a reaction represented by  $RH_x \rightarrow R + (x/2)H_2 \uparrow$ . As a result, at the second-stage sintering heat treatment, the R-rich phase at the grain boundary is swiftly turned into a liquid phase, permitting swift proceeding of the sintering process and shrinkage of the sintered body. The sintering process is therefore completed in a short period of time, and this suppresses the crystal grains from becoming coarse. As a result, the coercive force of the sintered magnet improves, and also the density of the sintered body increases.

The rare-earth magnet disclosed in Mikio does not include hydrogen at a weight ratio of 10 ppm to 100 ppm. As described in paragraphs [0008], [0009] and [0016] of

Mikio, the rare-earth magnet is produced by pulverizing the rare earth magnet material by grinding or milling (rather than by hydrogen embrittlement) and then performing a sintering process at 1080 °C and then heat treatment processes in multiple stages. If the sintering process is carried out as a single process step in this manner, a relatively small amount of hydrogen will be eventually released even though heat treatment processes are conducted in multiple stages after that. This is because unlike a heat treatment process performed before the sintering process, the heat treatment processes performed after the sintering process do not promote the decomposition of the rare-earth hydride ( $RH_x$ ) included in the grain boundary phase yet to be liquefied, as discussed at paragraph [0051] of the specification of the present application.

Accordingly, if a magnet was produced by processing the “a material obtained by embrittling an R-Fe-B rare earth alloy by hydrogen occlusion” according to the method described in Mikio et al., then the rare-earth hydride ( $RH_x$ ) would not be decomposed sufficiently before the material is subjected to the sintering process definitively. As a result, the hydrogen content of the resultant magnet could not be reduced to 5 ppm as disclosed in Mikio et al. without the mechanical grinding or milling process to form the magnet particles. In other words, unless the “material obtained by embrittling an R-Fe-B rare earth alloy by hydrogen occlusion” is used, the hydrogen content would easily be 5 ppm since virtually no hydrogen is introduced into the magnet material by the processing of Mikio. That is to say, Mikio et al. neither teach nor suggest using the “material obtained by embrittling an R-Fe-B rare earth alloy by hydrogen occlusion” or making a rare-earth magnet having “a hydrogen content in a range of 10 wt. ppm to 100 wt. ppm” of such a material. Additionally, while Mikeo et al do teach a relationship between the grain size of the rare earth magnets (see Table 1), the patentees do not teach or remotely suggest that the density and coercivity of a rare earth magnet, fabricated using the hydrogen embrittlement processing step, can be improved over single sintering step magnets as shown by the instant specification (see Tables 3 and 4).

As noted above, unless the “material obtained by embrittling an R-Fe-B rare earth alloy by hydrogen occlusion” is used, the material (powder) of Mikeo et al includes a relatively miniscule amount of hydrogen. Accordingly, even if the compact is

not sintered for a long time, it is rather easy to reduce the hydrogen content of the resultant magnet to less than 10 ppm, such as the 5 ppm taught by Mikio et al. In that case, the crystal grain size will not increase so much because the sintering process is briefly performed. On the other hand, if the “material obtained by embrittling an R-Fe-B rare earth alloy by hydrogen occlusion” is used, the material includes quite a lot of hydrogen. Thus, the first stage of the two-stage sintering process needs to be carried out for a rather long time to release the excessive hydrogen, and if the hydrogen content should be reduced to less than 10 ppm (e.g., 5 ppm), the first stage of the sintering process needs to be carried out for an extremely long time. The result of such a heating will be that the crystal grain size will increase excessively and the magnetic properties of the resultant magnet will deteriorate (see Table 1 of Mikio et al for the relationship of grain size to coercivity). In view of this consideration, according to the present invention, the magnet includes hydrogen at a weight of 10 ppm to 100 ppm as defined by amended claims of the present application. For these reasons, one of ordinary skill in the prior art would not have found it obvious to provide the sintered rare earth magnets of Mikio et al with a hydrogen content of 10-100 ppm as presently claimed as asserted by the Examiner. Consequently, the rejections of claims 11-15, under either § 102 or § 103, are now improper and must be withdrawn.

With regard to the rejections of claims 11, 13, 14 and 15, under 35 U.S.C. § 103(a), as being obvious in view of the teachings of WO 93/20567 (WO ‘567), the Applicants traverse these rejections for the same reason advanced above and for the additional reasons to follow. While WO ‘567 discloses a very broad range. i.e., 10-10000 ppm, for the hydrogen content which overlaps the narrow range of 10-100 ppm presently claimed, WO ‘567 does not suggest to reduce the hydrogen content into a range of 10 wt. ppm to 100 wt. ppm. Further, this document does not point out the problem caused by the rare-earth hydride ( $RH_x$ ) present in the alloy powder (paragraph [0051] of the specification of the present application) nor the solution, described above, to form a rare earth magnet having a hydrogen content of 10-100 ppm after dehydrogenation.

Additionally, while it may have been obvious to select the end point of the range of hydrogen concentration of WO '567, according to the guidance of *In re Wertheim*, 541 F.2d, 191 USPQ 90 (CCPA 1976) and *In re Woodruff*, 919 F.2d 1575, 16 USPQ 1934 (Fed. Cir. 1990), the selection of that range along with the narrow ranges for oxygen and nitrogen in the rare earth magnet presently claimed, may not be obvious, and further a finding of obviousness can be rebutted, if it can be shown that the particular subset has some criticality not recognized by the prior art, see MPEP Chapter 2144.05(III) and *In re Woodruff* (supra) which states:

"The law is replete with cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims. . . . In such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range."

In the instant case, as pointed out above, the Applicants have discovered that there is a relationship between the hydrogen content of the embrittled, sintered rare earth magnet and the ability to form sintered rare earth magnets having the desired density and coercivity (which does not deteriorate). Further, the Applicants have discovered (see Tables 3 and 4) each of these problems can be corrected by performing a sintering sequence which, in a first sintering step, reduces the content of hydrogen in the sintered rare earth magnet to the levels presently claimed. Such magnets have improved density and higher coercivity when compared to those magnets which do not undergo a dehydrogenation by the two-step sintering sequence disclosed.

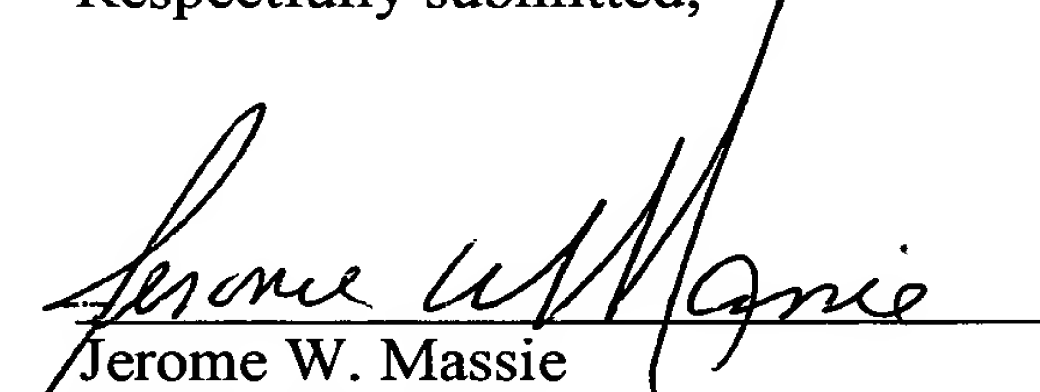
Since the Applicants have established an unobvious result for embrittled, sintered rare earth magnets, a *prima facie* case of obviousness, set forth by the Examiner with regard to the WO '567 teachings of 10-10000 ppm of hydrogen, has not been established for the specific rare earth magnets presently claimed and, even if established, the *prima facie* case of obviousness would be overcome by the unexpected results shown by the Applicants. Accordingly, the rejections of claims 11, 13, 14 and 15, under 35 U.S.C. § 103(a), as being obvious in view of the teachings of WO '567 are no longer appropriate and must be withdrawn.

While the present application is now believed to be in condition for allowance, should the Examiner find some issue to remain unresolved, or should any new issues

arise, which could be eliminated through discussions with Applicants' representative, then the Examiner is invited to contact the undersigned by telephone in order that the further prosecution of this application can thereby be expedited.

Lastly, it is noted that a separate Extension of Time Petition (three months) accompanies this response along with an authorization to charge the requisite extension of time fee to Deposit Account No. 19-2380 (743421-43). However, should that petition become separated from this Amendment, then this Amendment should be construed as containing such a petition. Likewise, any overage or shortage in the required payment should be applied to Deposit Account No. 19-2380 (743421-43).

Respectfully submitted,

  
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